

Title: Estimated Environmental Exposures for MISSE-7B

Authors: Miria M. Finckenor, Chip Moore, Joseph K. Norwood, Ben Henrie, NASA
Marshall Space Flight Center

Kim K. de Groh, NASA Glenn Research Center

This paper details the 18-month environmental exposure for Materials International Space Station Experiment 7B (MISSE-7B) ram and wake sides. This includes atomic oxygen, ultraviolet radiation, particulate radiation, thermal cycling, meteoroid/space debris impacts, and observed contamination. Atomic oxygen fluence was determined by measured mass and thickness loss of polymers of known reactivity. Diodes sensitive to ultraviolet light actively measured solar radiation incident on the experiment. Comparisons to earlier MISSE flights are discussed.



Estimated Environmental Exposures for MISSE-7B

Miria M. Finckenor

Chip Moore

Joseph K. Norwood

Ben Henrie (MITS)

NASA/Marshall Space Flight Center

Kim De Groh

NASA/Glenn Research Center

National Space and Missile Materials Symposium

Tampa, FL

June 2012

**Estimated Environmental Exposures
for MISSE-7B**



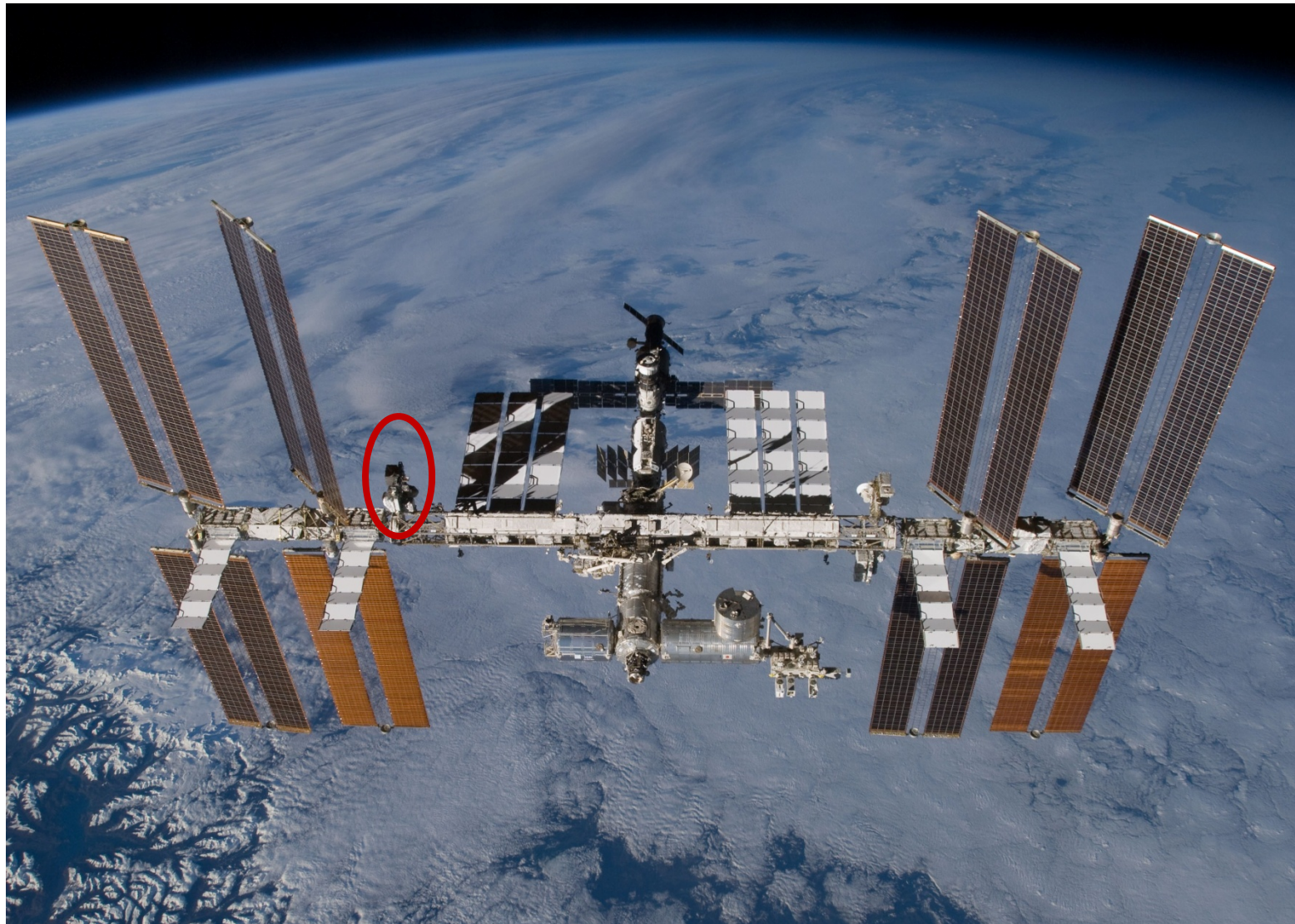
Materials on International Space Station Experiment (MISSE) - 7

Deployed: November 23, 2009 on STS-129

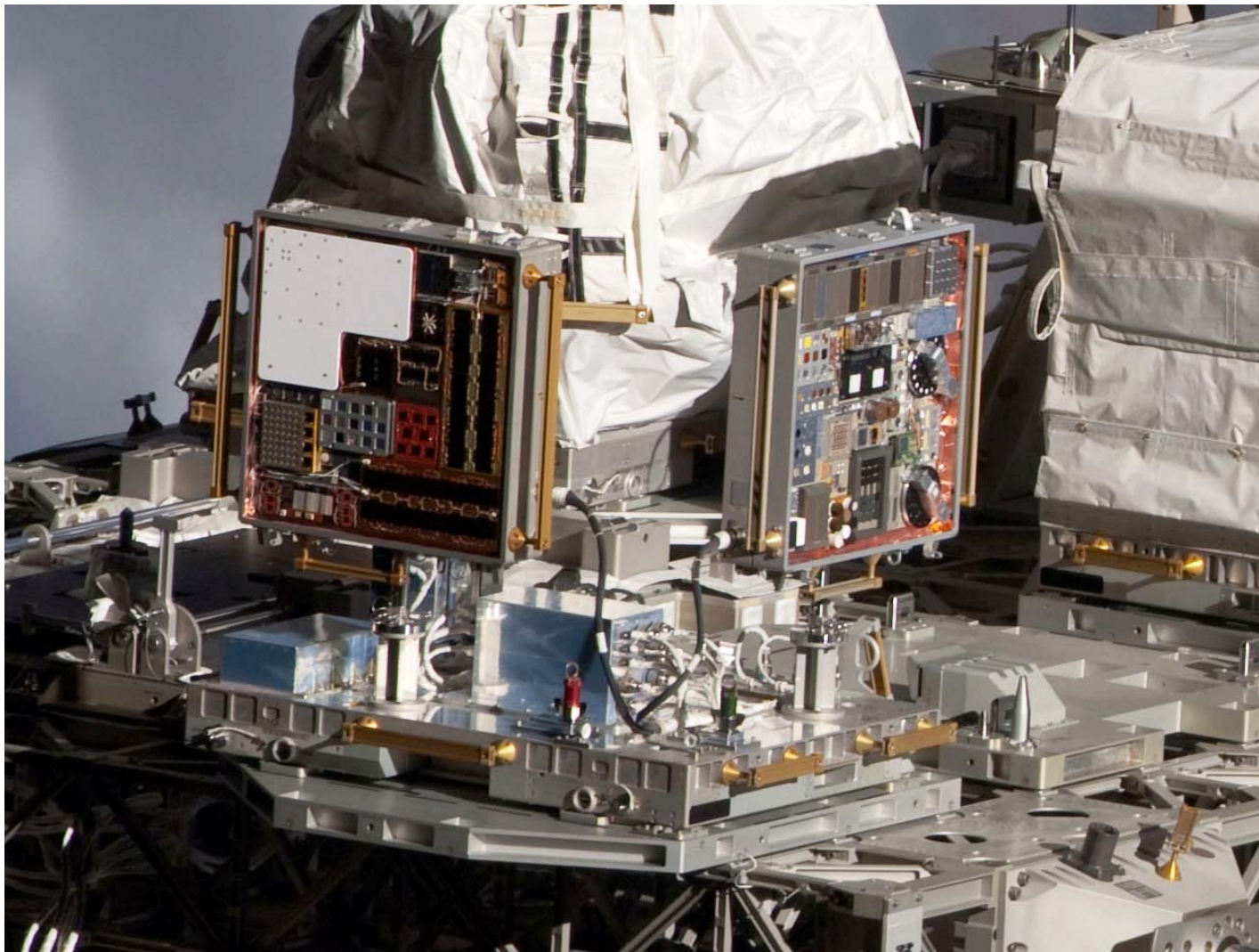
Retrieved: May 20, 2011 on STS-134

- Location on ISS - ExPRESS Logistics Carrier 2
- Pre-flight and post-flight photos
- Environmental exposure for MISSE-7B
 - Contamination evaluation
 - Meteoroid/orbital debris impacts
 - Atomic oxygen fluence
 - Ultraviolet radiation
- Discussion and conclusions
- Database development

Estimated Environmental Exposures for MISSE-7B



Estimated Environmental Exposures for MISSE-7B



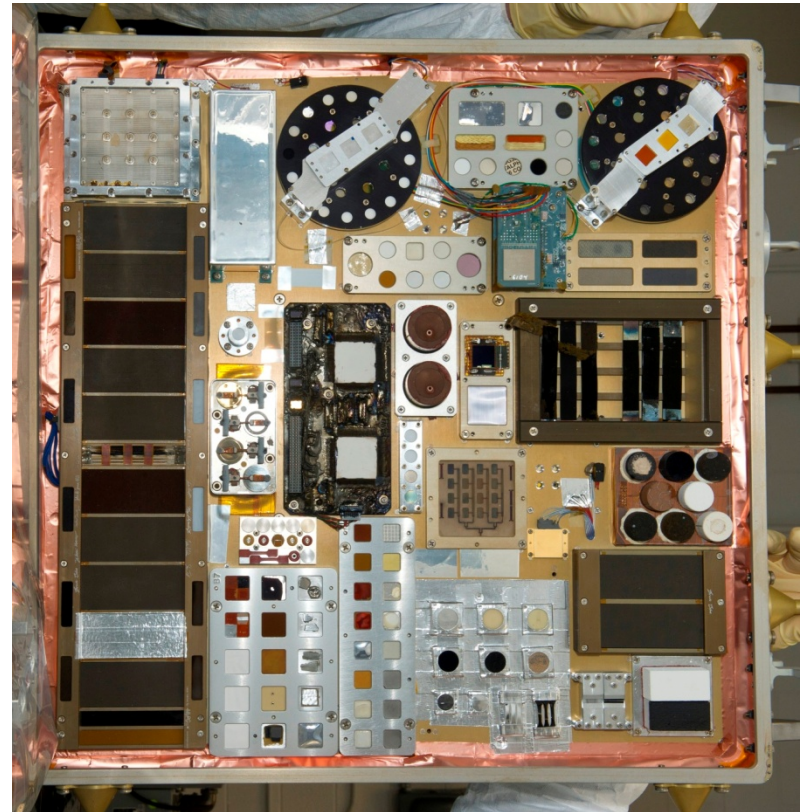
Estimated Environmental Exposures for MISSE-7B



Ram Side



Pre-flight



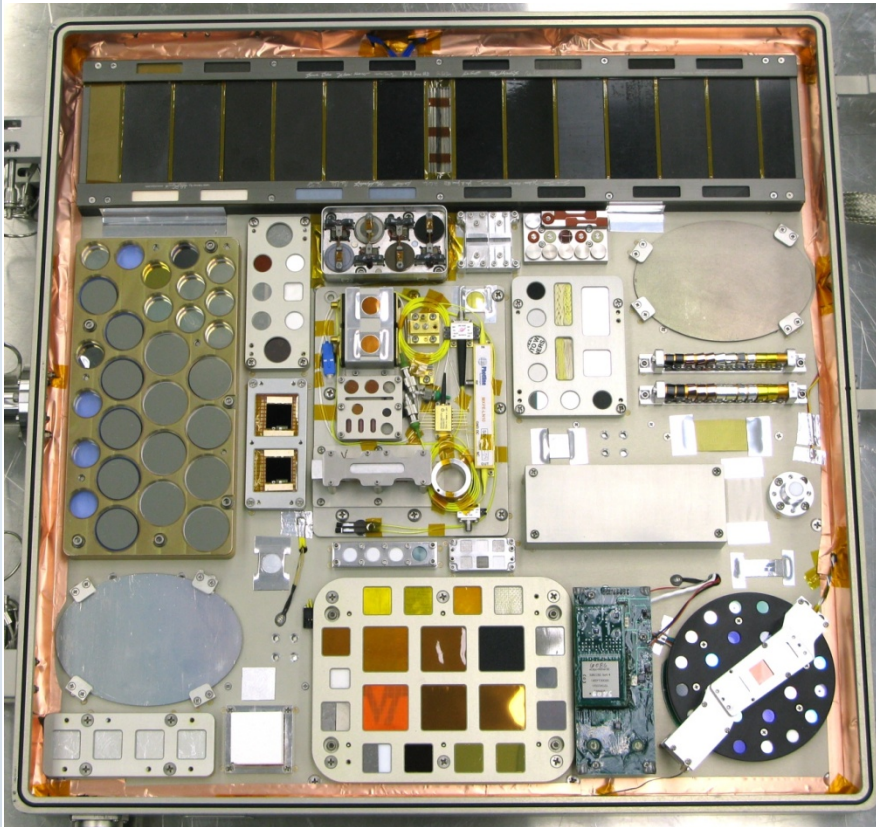
Post-flight

UV darkening of base plate, some loss of samples, particularly on tray A5-R

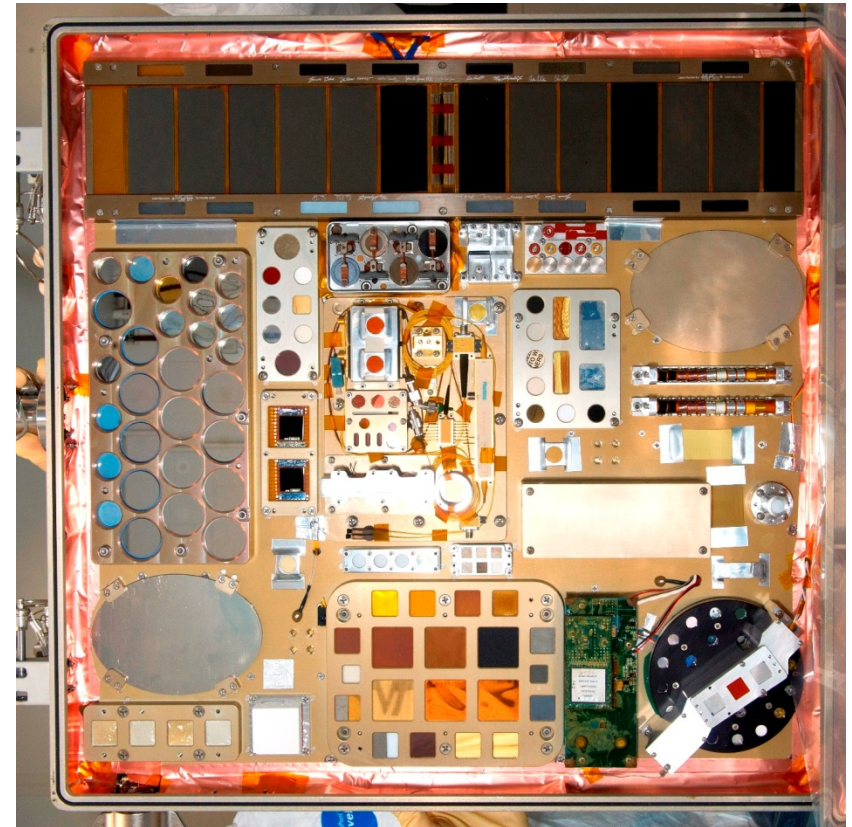
Estimated Environmental Exposures for MISSE-7B



Wake Side



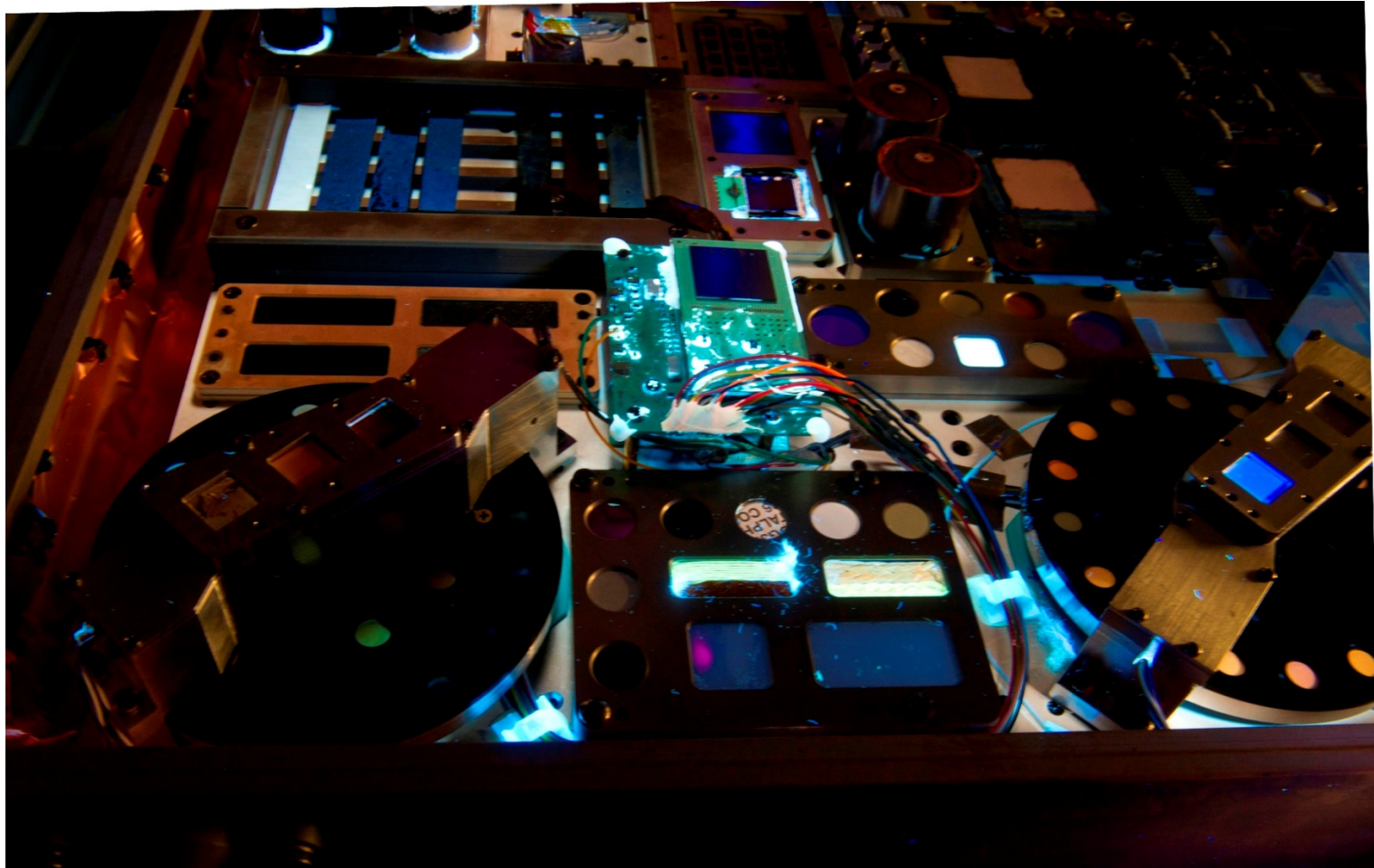
Pre-flight



Post-flight

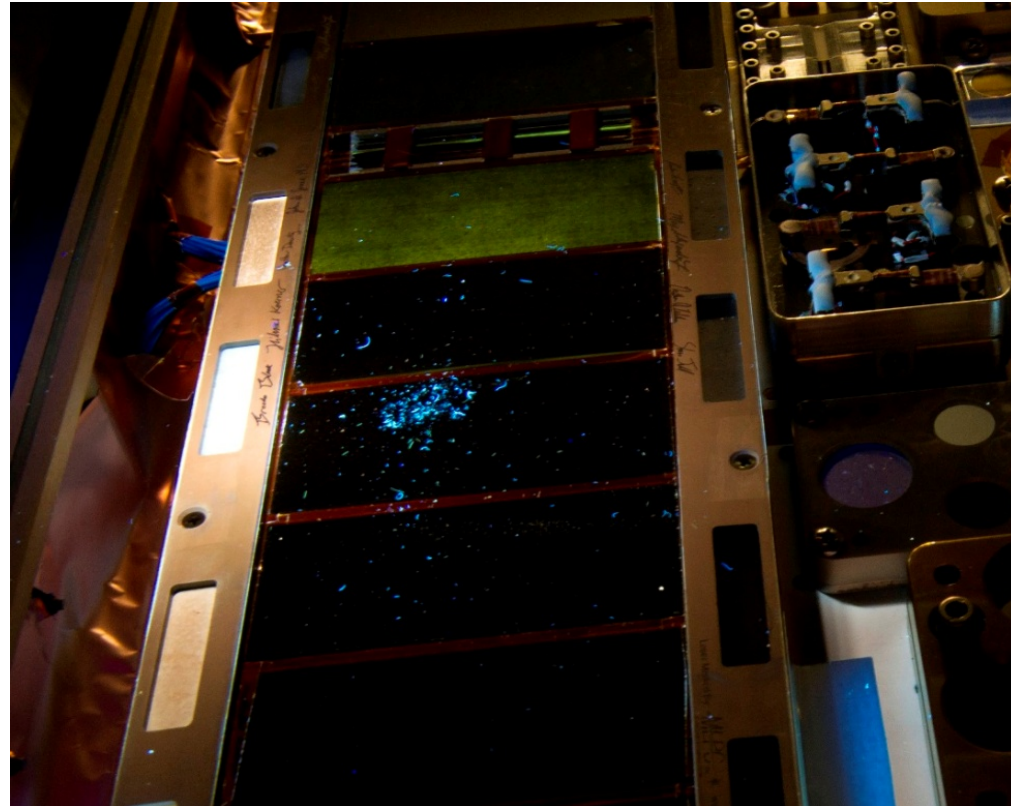
UV darkening of base plate

Estimated Environmental Exposures for MISSE-7B



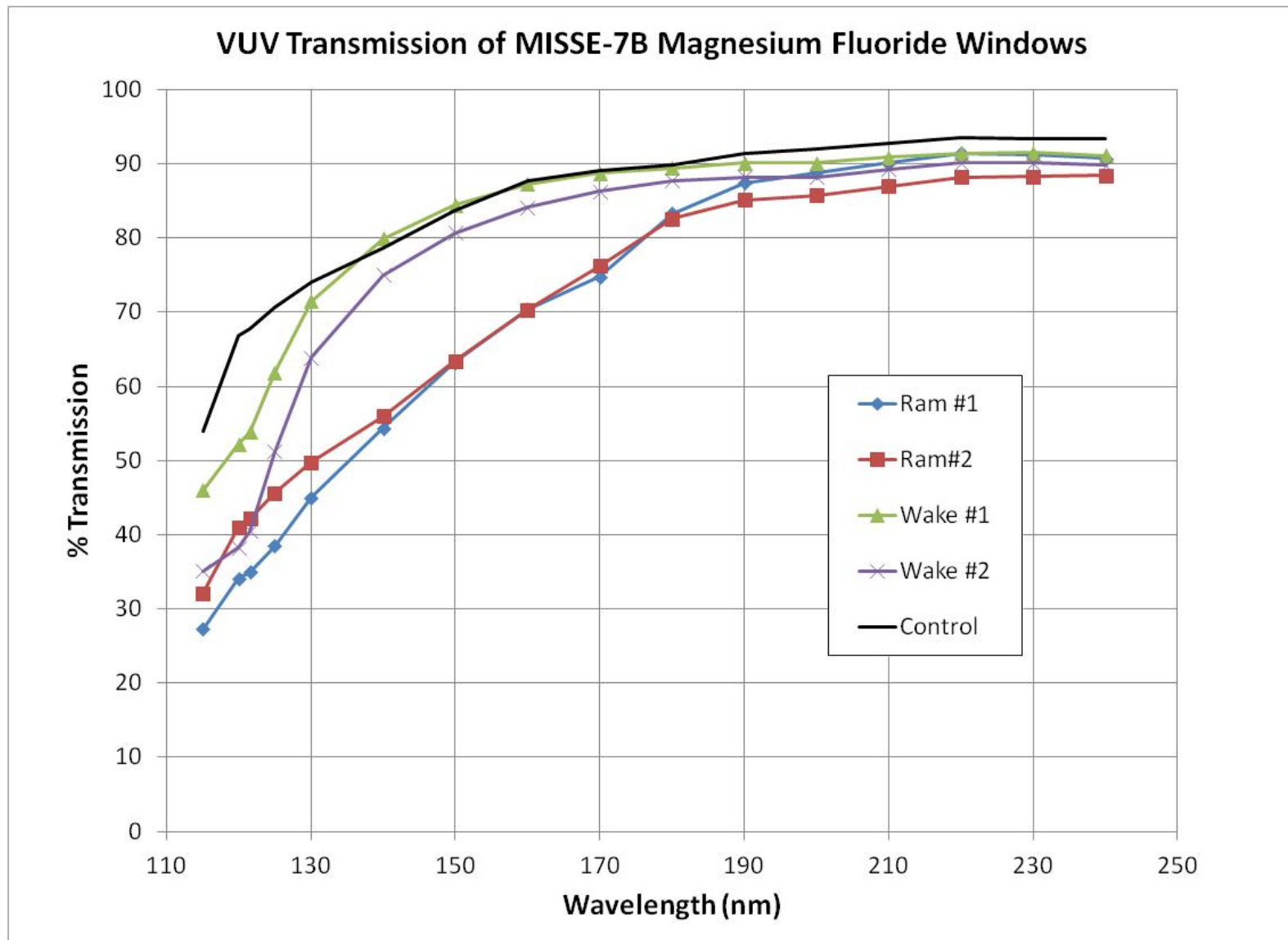
Some particulate from N10-R, also localized molecular contamination

Estimated Environmental Exposures for MISSE-7B



Particulate contamination on A1-W – fallout from N10-R,
heavily eroded Vectran yarn

Estimated Environmental Exposures for MISSE-7B





Contamination

- Magnesium fluoride windows shows some decrease in transmission only in the VUV wavelengths, likely due to atomic oxygen interaction.
- AZ93 white ceramic thermal control coating
 - Control $\alpha = 0.158$
 - Ram $\alpha = 0.159$
 - Wake $\alpha = 0.157$
- Ellipsometry on platinum mirrors indicated 40 Å of SiO_x or less.



Meteoroid/Space Debris Impact Survey for MISSE-7B

- Ram – 12 impacts
- Wake – 6 impacts
- Sidewalls – 7 impacts

Total of 25 impacts

Largest 1 mm diameter

Estimated Environmental Exposures
for MISSE-7B



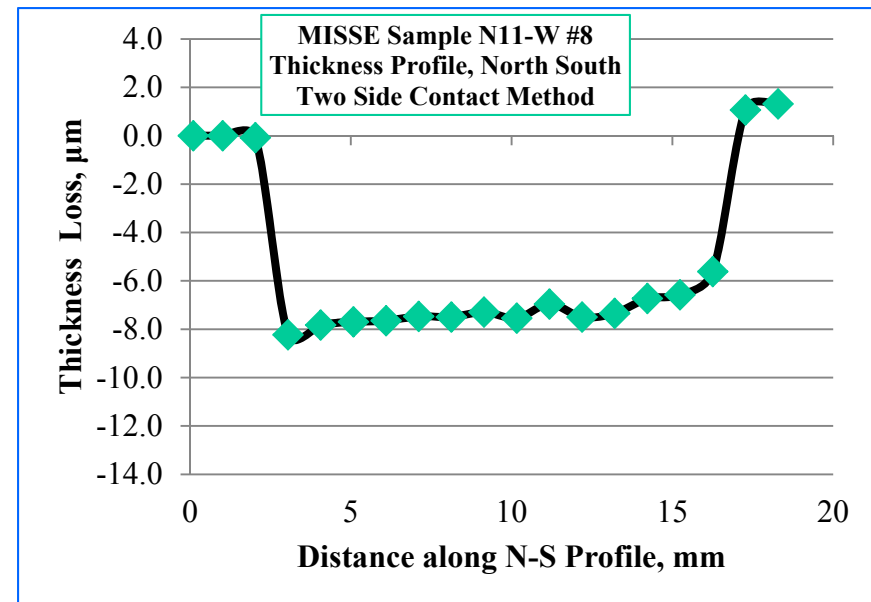
Atomic Oxygen Fluence

Determined by mass loss and thickness loss of Kapton HN

Ram side: $4.2 \pm 0.1 \times 10^{21}$ atoms/cm²

Wake side: $2.9 \pm 0.3 \times 10^{20}$ atoms/cm²

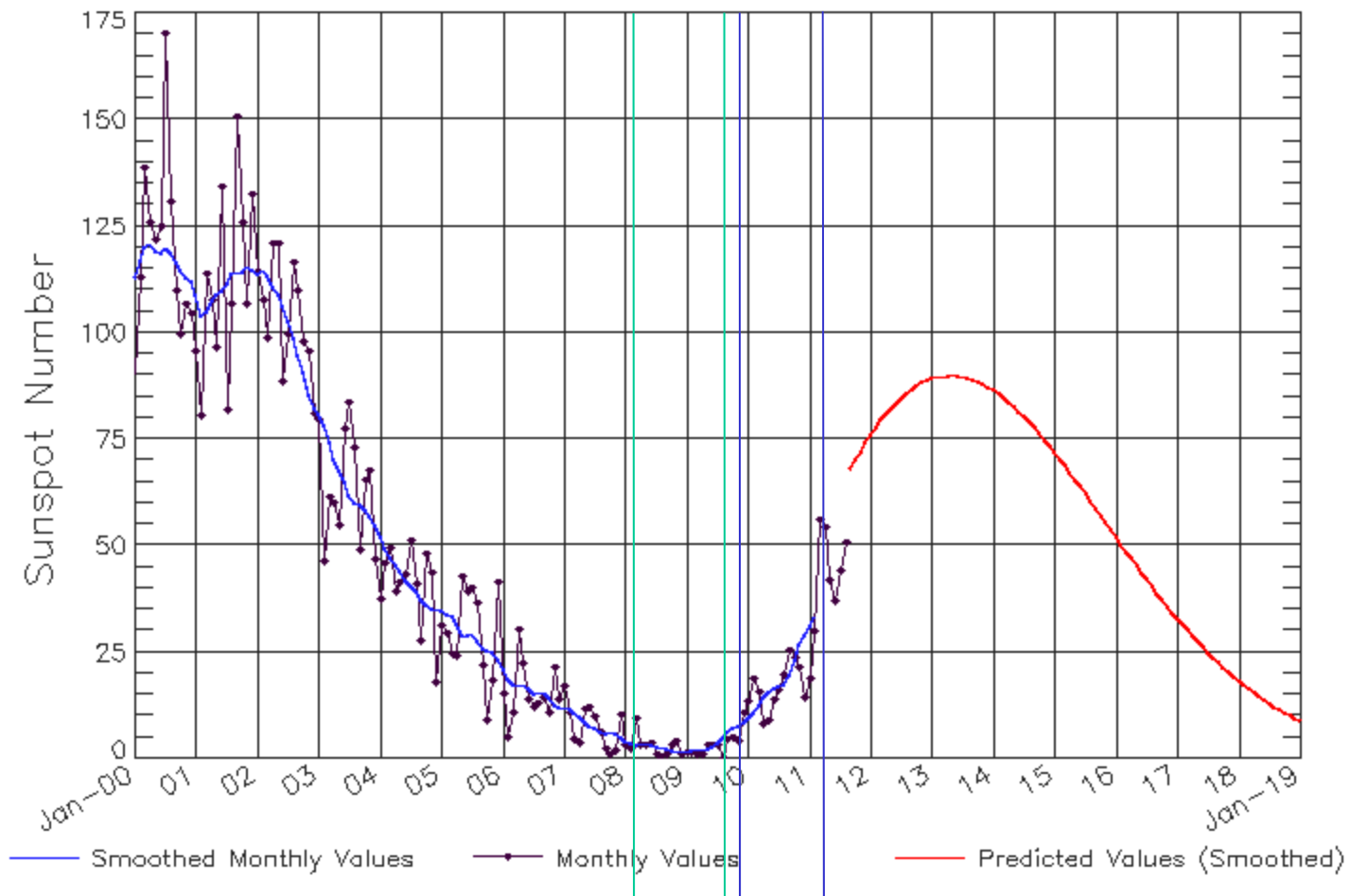
Glenn Research Center
confirmed AO fluence
for the ram side as
 4.18×10^{21} atoms/cm²



Estimated Environmental Exposures for MISSE-7B



ISES Solar Cycle Sunspot Number Progression
Observed data through Aug 2011

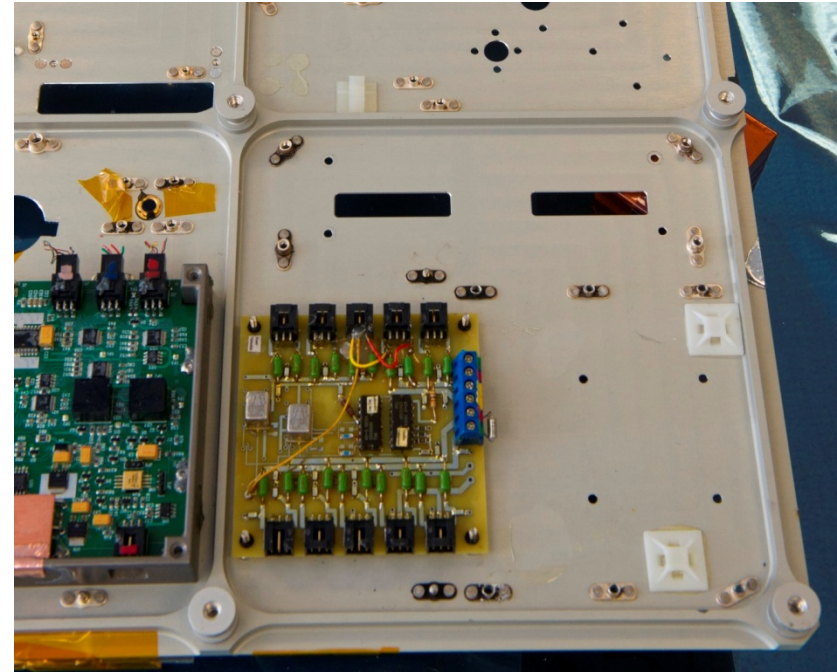
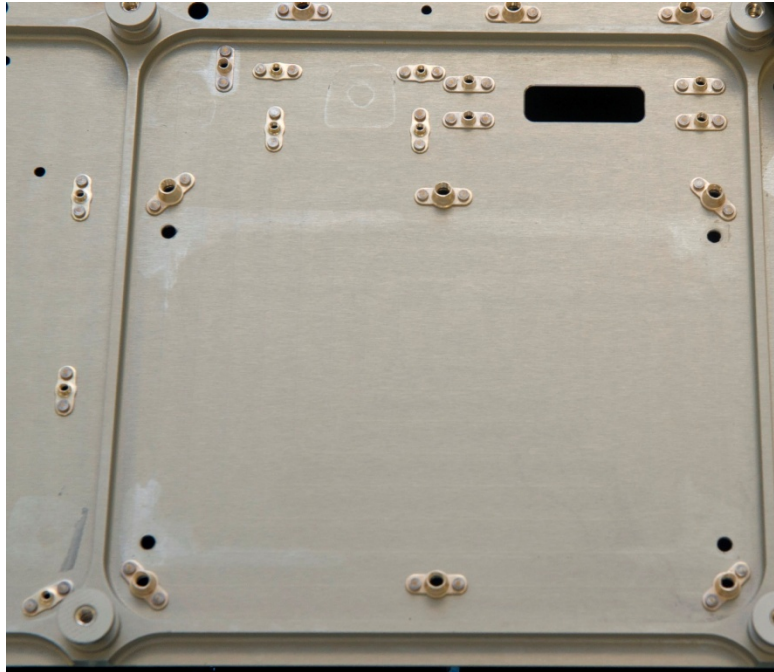


Updated 2011 Sep 6

MISSE-6 MISSE-7

NOAA/SWPC Boulder, CO USA

Estimated Environmental Exposures for MISSE-7B



Copper tape between baseplate and PEC meant very little AO scattered underneath baseplate, very little silver oxide formed on nutplates.

**Estimated Environmental Exposures
for MISSE-7B**



Ultraviolet Radiation

UV diodes on ram and wake

Monitored by Lead-Free
Technology Experiment in
Space Environment (LTESE)

Ram: 4,500 +/- 400 ESH

Wake: 3,200 +/- 200 ESH





Conclusions

- ◆ Some localized molecular and particulate contamination.
- ◆ No significant change in number or size of meteoroid/space debris impacts.
- ◆ Higher atomic oxygen fluence than MISSE-6 due to increased solar activity.
- ◆ Higher ultraviolet radiation dose than MISSE-6 due to different location and less shielding.

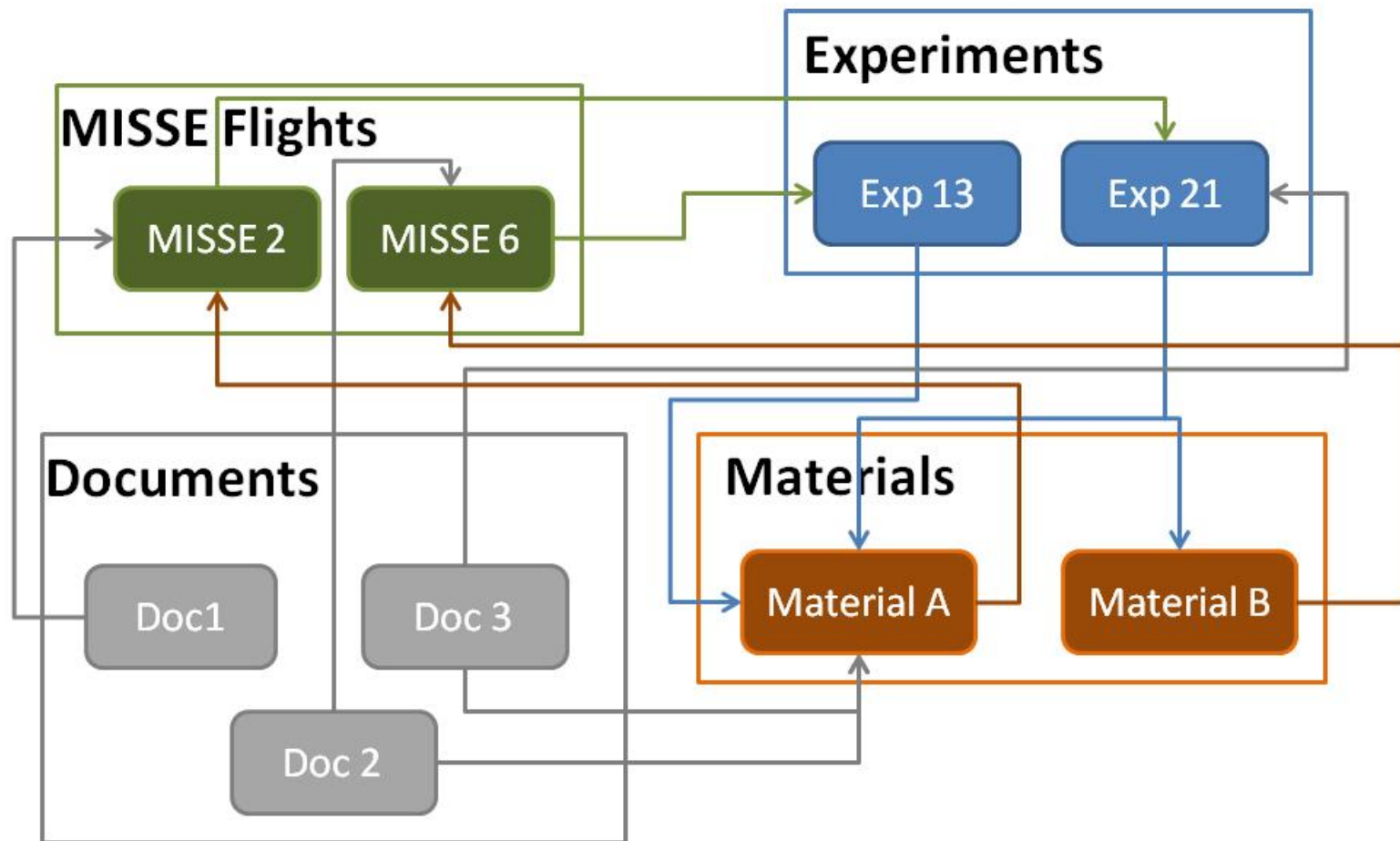


What's next?

- ISS/Julie Robinson has provided funding to add a MISSE database to the Materials and Processes Technical Information System (MAPTIS)
- MISSE 1- 7 for now. Raw data from MISSE-8 is being stored at Huntsville Operations Support Center (HOSC)'s long term storage system.
- Papers, presentations, overall and individual sample photographs, specimen lists, sample layouts, raw data files



Unstructured Data



Estimated Environmental Exposures for MISSE-7B



MAPTIS

MATERIALS AND PROCESSES TECHNICAL INFORMATION SYSTEM



SEARCH →

[Advanced Search](#)



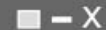
Browse By

MISSE Flights

MISSE Experiments

MISSE Materials

MISSE Flights



MISSE Flights

MISSE 1	Experiments	Materials	Data	Docs	Images
MISSE 2	Experiments	Materials	Data	Docs	Images
MISSE 3	Experiments	Materials	Data	Docs	Images
MISSE 4	Experiments	Materials	Data	Docs	Images
MISSE 5	Experiments	Materials	Data	Docs	Images
MISSE 6A	Experiments	Materials	Data	Docs	Images
MISSE 6B	Experiments	Materials	Data	Docs	Images
MISSE 7	Experiments	Materials	Data	Docs	Images

Estimated Environmental Exposures for MISSE-7B



MAPTIS

MATERIALS AND PROCESSES TECHNICAL INFORMATION SYSTEM



SEARCH →

[Advanced Search](#)



Browse By

MISSE Flights

MISSE Experiments

MISSE Materials

MISSE Flights

MISSE Flights

Experiments on MISSE Flight - MISSE 2

Experiments

AZ electrically conductive white	Flights	Materials	Data	Documents	Images
AZ93 on composite	Flights	Materials	Data	Documents	Images
AZ electrically conductive black	Flights	Materials	Data	Documents	Images
AZ93 on substrates	Flights	Materials	Data	Documents	Images
A-276 with 15 % leafing aluminum	Flights	Materials	Data	Documents	Images
Silverized Teflon with SiOx	Flights	Materials	Data	Documents	Images
germanium on Kapton	Flights	Materials	Data	Documents	Images

Estimated Environmental Exposures for MISSE-7B





MAPTIS
MATERIALS AND PROCESSES TECHNICAL INFORMATION SYSTEM

SEARCH 

[Advanced Search](#)

Browse By

MISSE FlightsMISSE ExperimentsMISSE Materials

MISSE Flights

Experiments on MISSE Flight - MISSE 2

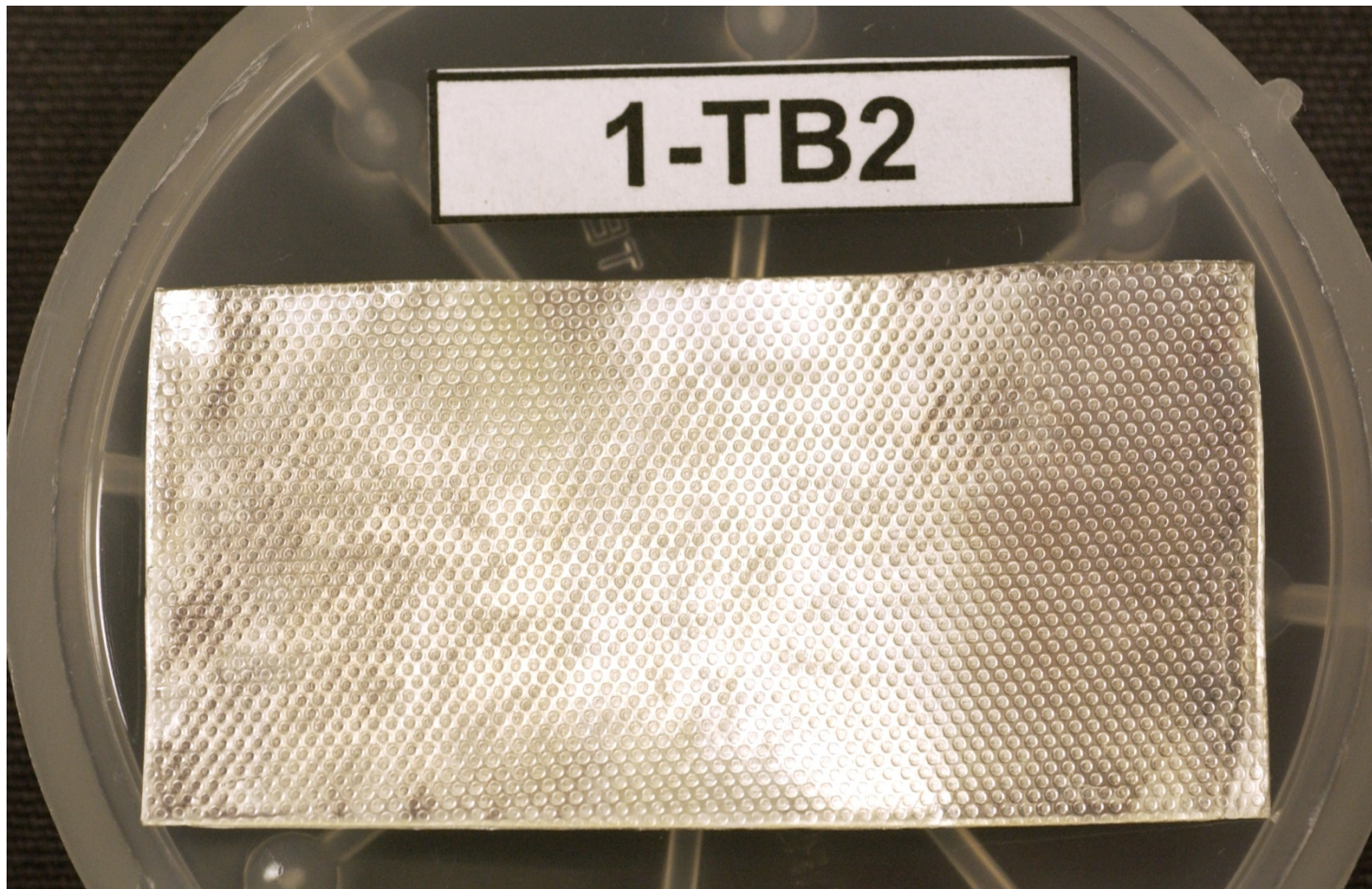
Materials on Experiment: Silverized Teflon with SiOx

Materials						
Material A	Flights	Experiments	Materials	Data	Documents	Images
Material B	Flights	Experiments	Materials	Data	Documents	Images
Material C	Flights	Experiments	Materials	Data	Documents	Images
Material D	Flights	Experiments	Materials	Data	Documents	Images
Material E	Flights	Experiments	Materials	Data	Documents	Images
Material F	Flights	Experiments	Materials	Data	Documents	Images
Material G	Flights	Experiments	Materials	Data	Documents	Images

Estimated Environmental Exposures
for MISSE-7B



MISSE-2 wake side Silver/Teflon with SiO_x - postflight image



Estimated Environmental Exposures
for MISSE-7B



NSMMS presentation with MISSE-2 wake side Silver/Teflon
with SiOx - data



Analysis of International Space Station Vehicle Materials
on MISSE 3 & 4



MISSE-1, -2, 3, -4 Results for Silverized Teflon

		Preflight	Postflight	Δ	Environment
5.5 mil with SiOx TB1	α	N/A	0.08		6,600 ESH
	ϵ	N/A	0.80		9E+21 O atoms/cm ²
5.5 mil with SiOx TB2	α	N/A	0.08		6,600 ESH
	ϵ	N/A	0.80		1.1E20 O atoms/cm ²
5.5 mil with SiOx 1-E13-3	α	0.10	0.11	+0.01	1,750 ESH
	ϵ	0.82	0.79	-0.03	1.2E21 O atoms/cm ²
5.5 mil with SiOx TB3	α	N/A	0.09		1,750 ESH
	ϵ	N/A	0.79		1.2E21 O atoms/cm ²
5.5 mil with SiOx TB4	α	N/A	0.10		1,750 ESH
	ϵ	N/A	0.79		1.9E20 O atoms/cm ²
10 mil, no coating 1-E3-46	α	0.09	0.08	-0.01	6,600 ESH
	ϵ	0.84	0.85	+0.01	9E+21 O atoms/cm ²
10 mil, no coating W7-12	α	0.09	0.09	-	680 ESH
	ϵ	0.84	0.85	+0.01	1.9E20 O atoms/cm ²

[illegible]

**Estimated Environmental Exposures
for MISSE-7B**



For access to MAPTIS

<http://maptis.nasa.gov/Request.aspx>

and fill out the form.

To add MISSE data to MAPTIS

Contact ben.henrie@nasa.gov or miria.finckenor@nasa.gov

Miria – 256-544-9244

Be sure to specify whether your information is unlimited
access or ITAR-restricted



Acknowledgments

- Annette Sledd, Ginger Flores, Julie Robinson, Kevin Window, Rod Jones, Julie Henkener, and John Alred for their support
- Phil Jenkins, Rob Walters, John Vasquez, and others at the Naval Research Laboratory and Dr. Gary Pippin and others at Boeing Research & Technology , for getting MISSE-7B off the ground.
- Susie LaCava of the Naval Research Laboratory for pre-flight photos.
- Richard A. Caldwell, DoD Space Test Program, Human Spaceflight Payloads Office
- Brian Gibson for the UV diode data through the LTESE experiment.
- Tiffany Russell for handcarrying MISSE-7B back to MSFC